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Division of Chemistry

Observations on European Agriculture

BY
G. S. FRAPS, Chemist

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Observations on European Agriculture

By G. S. FRAPS

The object of this Bulletin is to present such observations on agriculture in Europe as may offer suggestions of value to Texas agriculturists.

The writer, in company with others interested in the subject, in the summer of 1911 made a trip through Scotland, England, France, Switzerland, Germany, Denmark, Holland and Belgium, for the purpose of studying agricultural conditions. The leader of the party was Dr. J. A. LeClerc, Chief of the Division of Vegetable Physiology of the Bureau of Chemistry of the U. S. Department of Agriculture, and it was organized by the Bureau of University Travel of Boston, Mass. The party visited agricultural colleges, experiment stations, farms, chemical control stations, creameries, forests, high schools, and other places of agricultural interest. Authorities in agriculture were very kind in showing the matters of importance in their particular section, giving us information and entertaining us. Particular mention is due to Dr. Du Vuyst, Inspector General for Agriculture in Belgium, who accompanied us for a large portion of the trip.

As we have stated, the object of this Bulletin is to present such observations or conclusions pertaining to agriculture as might prove servicable or useful to the agricultural interests of Texas. Matters of general interest will not be discussed, nor will this Bulletin contain any detailed report of the trip, nor general or scientific accounts of the many visits to experiment stations, colleges, farms, etc., excepting as may be considered desirable for the purposes of this Bulletin.

MAINTENANCE OF FERTILITY.

The land of Europe has been, in many cases, in cultivation for centuries. In spite of this, good crops are still produced.

The following are the yields per acre of wheat in several European countries, and in the United States, as given in the Year-book of the U. S. Department of Agriculture for 1907.

	Average yield of wheat 1897-1906 in bushels per acre
England and Scotland	32.2
Germany	28.0
France	19.8
Austria	17.8
United States	13.8
European Russia	9.2

That is to say, European averages, except for Russia, are greater than those for the United States.

Indeed, in some countries the yield has increased:

Average yield of wheat and oats in France. (Bushels per acre.)

	Wheat.	Oats.
1815-24	12.4	17.5
1825-34	14.1	18.5
1835-44	14.9	21.0
1845-54	15.8	23.7
1855-64	16.6	26.0
1865-74	16.6	25.6

The increased yield is due to improved methods of farming and restoring soil fertility, and the table is evidence that even though soils may have been cultivated for centuries they can be maintained or even increased in fertility by methods now known.

HOW FERTILITY IS MAINTAINED.

To the inquiry, to what is this fertility of European soil due, after so many years of cultivation, we answer:

First, it is due to the general system of a *rotation of crops*, which includes leguminous crops to gather nitrogen from the air, and thereby enrich the soil. The crops are never turned under but are fed and the manure saved.

Second, it is due to a general use of a system of grain and live-stock farming in which all the *manure*, both *solid* and *liquid*, is carefully saved and returned to the soil. We do not mean to say that live stock farming is practiced exclusively, but the great bulk of the farm land is devoted to grain and live stock, either for meat or dairy products. Where other knds of farming are practiced, we find the same principles in use, namely, rotation of crops, use of manure and of fertilizers.

Third, it is due to the *purchase of imported feeding stuffs* from America and other countries, whereby plant food is secured, and saved in the manure for the purposes of soil fertility.

Fourth, it is due to the extensive use of *commercial fertilizers.*

Fifth, it is due to the use of lime where needed.

Sixth, it is due to the prevention of loss of plant food from the farm. Thus, many landlords do not allow hay or straw to be sold, unless there is an equivalent purchase of plant food in the form of other feeding stuffs, or of manure. Hay, it is well recognized, carries a large amount of plant food in proportion to its selling price.

In other words, the fertility of European soils is maintained by maintaining the supply of active plant food, and of organic matter. A part of the nitrogen is secured from the air, a part from the purchased feeding stuffs, and some from nitrogenous fertilizers. The losses of potash and phosphoric acid in the crop are counterbalanced by purchases in feeds and fertilizers. Every care is taken to prevent loss of plant food. Leaves, stalks, etc., are either saved and fed, or are used as bedding.

ROTATION OF CROPS.

The general principles of crop rotation are well recognized in Europe, and crop rotation is fixed by general practices and in the laws and customs of the people. A farmer who does not practice rotation is considered as a poor farmer, and in case his practice results in injury to the fertility of the soil, he is responsible to the owner of the land and will be made to pay damages. We found rotation of crops practiced even in forests and in nurseries where stock of various ornamental trees and shrubs are grown. We found some rotation of crops in every locality visited, and always this rotation included a leguminous crop, which was made into hay, fed, and the resulting manure returned to the soil. In this way, nitrogen is secured from the air for the use of other crops. Indeed, we were told in Switzerland, that the rotation there used was sufficient to maintain the nitrogen supply of the soil, and that practically no nitrogenous fertilizers are purchased there for ordinary farming. The significance of this fact is more fully realized when we consider that nitrogen in a commercial fertilizer in Texas is valued at 20 cents a pound, while potash and phosphoric acid have a valuation of only 6 cents each.

From Rothamsted rotation experiments, Dr. Hall concludes: "The inclusion of a clover crop in the rotation, besides providing a crop of hay, leaves the land so much richer in nitrogen that the succeeding wheat crop is greatly increased. The good effect of the clover persists and may be traced through all the crops of the rotation. With beans in place of the clover, no beneficial effect is produced on the succeeding crop." "The losses of nitrogen to strong land farmed on the four course system, are almost made up by the growth of a crop of clover, and will be more than repaired by dressing of 15 tons of farmyard manure or its equivalent, in the rotation." Another principle to be considered in crop rotation is the alternative of deep and shallow rooted plants. The deep rooted crops remove less of the nutrients from the surface soil, while the deep soil is not drawn upon for food for the shallow rooted plants. Hence on alternations of deep and shallow rooted plants they utilize a larger depth of soil than either kind alone. Alfalfa, clover and some native prairie grasses are deep rooted. Indian corn, oats, wheat and some meadow grasses have moderately long roots. Barley, turnips, many cultivated grasses, and rice. have shallow roots. Indeed, it is quite probable that the reason rice soils often decline rapidly in fertility is the shallow depth of the soil occupied and drawn upon by the roots.

Another reason for rotation is that different crops draw differently upon the plant food of the soil. A proper rotation of crops thus utilizes the various nutrients in the soil, better than the growth of a single crop continuously.

Another reason for rotation is that it eliminates weeds which persist when a single crop is grown. The treatment required by the proper crop in the rotation will eliminate weeds which accompany other crops and aid in keeping the soil clean.

Plant diseases, and insects, are also checked by a proper rotation. The continuous growth of any one plant favors the increase of insects or diseases which live in the soil. Rotating with a crop which is not affected by these pests, results in checking their action and may indeed eliminate them entirely. The remedy for cotton root rot, for example, is to grow corn or sorghum or some other crop not affected by the disease, long enough to starve it out.

We will not further discuss rotation in this Bulletin, but there is no doubt that the working out and adoption of suitable rotations which shall maintain and increase the fertility of the soils of the United States, is the most important problem facing the Experiment Stations. It is of course important to increase the yields of given crops—such as corn, by selection, cultivation, etc., but it is still more important to insure that our soils shall increase in fertility, and in seeking large yields we should not decrease the fertility of our soils more rapidly—or at such an expense for fertilizers as to render the increase unprofitable. The increase should be brought about in connection with such methods of farming as shall maintain and increase the fertility of the soils.

Rotations Practiced.—The rotations used are not, of course, directly applicable to American conditions. Some of the rotations we observed are as follows:

Near Edinburgh, Scotland:

First crop, roots.

Second crop, barley.

Third crop, rye grass and clover, mixed, mostly clover. Cut once or twice for hay, feed the hay and return the solid and liquid manure.

Fourth crop, oats.

Fifth crop, potatoes.

Sixth crop, beans, sometimes omitted.

Seventh crop, wheat.

All hay and straw fed on the farm, and the manure, both solid and liquid, is carefully saved and applied. Fertilizers are also used on the different crops in rotation.

Rotation, Dalmeny Park, near Edinburgh, Scotland:

(1) Grass and clover turf.
(2) Oats.
(3) Potatoes or roots.
(4) Oats or wheat.

Seeded down with clover and rye grass.

Dijon, in France.

(1) Alfalfa 3 years—to kill Canada thistles.
(2) Wheat.
(3) Roots or potatoes, with manure and 200 lbs. kainit.
(4) Wheat—200 lbs. superphosphate.
(5) Alfalfa.

Sheep were herded and fed on this land, 300 sheep moved every 8 hours.

Berne, Switzerland:

(1) Clover and grass 3 years—fed and manure saved.
(2) Potatoes or oats.
(3) Roots or potatoes.
(4) Wheat or barley.

Nykobing, Denmark.

(1) Oats on clover turf.
(2) Sugar beets, with 500 lbs. acid phosphate, 300 lbs. nitrate of soda and 10 tons farm manure. Half of the beets are for sugar and half for feeding.
(4) Grass and clover for hay (2 years).

Much land is in alfalfa, which is permanent.

GRAIN AND LIVE STOCK FARMING.

It is a well known fact that when the manure is carefully saved, live stock farming makes comparatively slight demands upon the fertility of the soil. Butter contains no plant food. Milk and cheese contain some, but not large compared to the value of the product.

The same is true when live stock is grown for market purposes. The plant food eaten in the food is, for the most part, excreted and returned to the soil. There are, however, losses from the manure. Only a comparatively small portion of the plant food is retained in the bodies of the animals sold. Grain farming removes more of the plant food in the finished product, particularly nitrogen and phosphoric acid, but there is only slight loss of potash when the straw is saved and returned to the land.

On the other hand, there are farm products which contain and carry off large quantities of plant food in proportion to the commercial value of the product. This is the case particularly with hays and straws. On European farms, such products are often not sold, and when they are, the landlord usually requires purchase of compensating quantity of food or fertilizer. (See form of lease, page 21.)

Fig. 1—Hay Stacks on valuable Scotch land.

SAVING OF MANURE.

No small part in the system for maintaining and increasing the fertility of European soils is played by the careful saving and application of manure. Not only are the solid and liquid excreta of the animals carefully conserved, but all farm waste which may contain fertility or which may add organic matter of the soil, goes into the manure pile if it cannot be better utilized. Forest leaves, ashes, bones,. etc., are all made useful.

The value of liquid manure is well recognized in Europe, but it is not so well recognized in this country. As a matter of fact, over half of the fertilizing value of the feed goes into the liquid excrement. In Bulletin 104 of the Texas Experiment Station, it was shown that when a ration of cottonseed meal and hulls alone or with kafir, milo or molasses, was fed, about 42 per cent of the fertilizing value of the feed goes into the solid excrement, and 53 per cent into the liquid excrement. Thus, if a ton of cottonseed meal is fed, having a fertilizer vaulation of $30.00, the portion of its fertility which goes into the solid excrement has a valuation of $12.60, and that which goes into the urine has a valuation of $15.90. Both these values are often lost to American feeders, but to European feeders, cottonseed meal has a value of about $20.00 per ton more than to such American feeders.

In Europe, it is considered that a part of the profit of keeping animals lies in the manure; sometimes, all the profit. If the animal sells for enough to pay cost of feed, care, and maintenance, then the manure makes the profit. It is considered as exceedingly poor farming for one not to save manure, both solid and liquid, as carefully as possible.

All the cattle sheds or barns which we saw had stone or concrete floors. The barnyard or shed in which the manure is stored, also had stone pavements. The liquid manure was either absorbed by peat, or else run through stone or concrete troughs into a stone tank. If run in a tank, at intervals during the year, the liquid manure is pumped into tank carts, and distributed, generally on grass land. The leaching from the manure piles run into the liquid manure cistern.

We saw a number of methods of saving or preserving the manure, but each attempted to save as much as possible of the fertility for the purpose of applying it to the land.

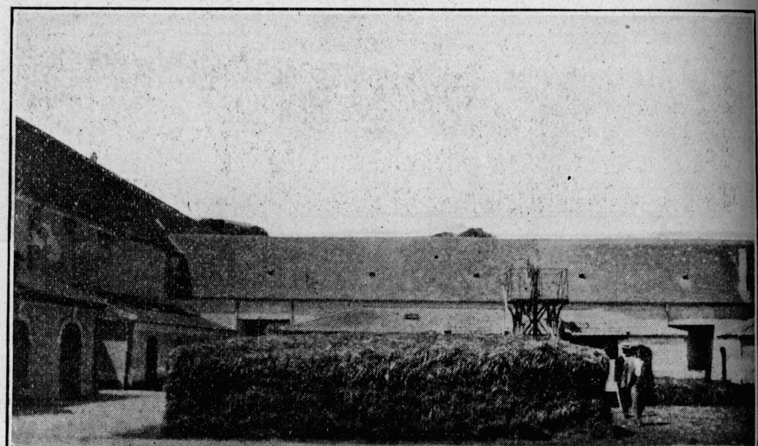

Fig. 2—Manure pile, Grignon (France) Experiment Station. The pump for elevating the liquids is at the left, to the rear.

Grignon Method.—In this method, the manure is piled upon a stone pavement in the farm courtyard in flat, well tramped layers. The liquid manure and the drainings from the manure pile run into a stone cistern. From time to time the liquid manure is pumped over the pile of solids. The object of this is to keep the manure moist and to prevent loss by excessive fermentation, and also to cause the manure to decompose evenly. When thoroughly rotted the manure is a very dark, brittle mass, and is said to be very effective in its action.

We saw this method at the Grignon Experiment Station, in France, and it is said to be extensively used all over France.

Liquid Manure Method.—In this method, liquids and solids are kept separate. The liquids are allowed to accumulate, and are pumped into tank carts for distribution. At Ruetti in Switzerland, the liquids are pumped out about six times a year. This method seems to be used extensively in Germany, Belgium and Holland.

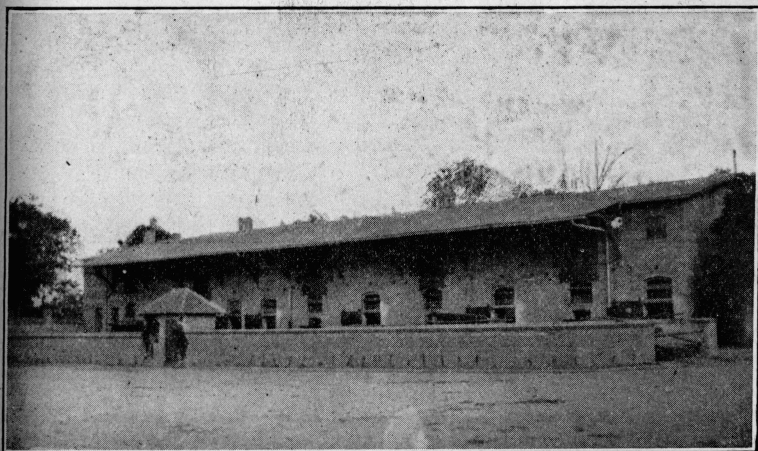

Fig. 3—Paved manure enclosure near Halle, Germany, in the foreground. The cattle exercise on the manure. Dairy barn to the rear.

Deep Stall Method.—The animals are kept in deep stalls with paved floors, in which the manure is allowed to accumulate. The feeding racks and water vessels are swung on chains, so that they can be raised as the manure accumulates.

Absorption Method.—The liquid manure is taken up by some absorbent, and taken out with the solids. On account of its high absorptive power, peat is generally used. We saw this system at a dairy farm near Berlin (Germany) and a cheese farm in Holland. At Gimritz, the washings from the floor of the cow barn run into a cistern and were used as manure. Two to three pounds peat per animal per day are used. Dirt, sawdust, etc., are also used as absorbents.

Pasturing and Feeding Off Crops.—When the crops are pastured or fed off, the manure is, of course, dropped directly on the land. We saw a good deal of pasture land in England and Scotland, but very little on the continent of Europe. Land there is too expensive to be used for this purpose. Feeding off crops, or grazing stubble, is seen more generally. In Denmark we saw considerable fields of alfalfa being grazed. The cows are staked out in regular rows about 30 feet apart, with ropes about 15 feet long, and are kept out day and night. Water is brought to them in the field and they are milked there. This goes on, however, only for a short time during the summer. In the winter, the cows are kept up.

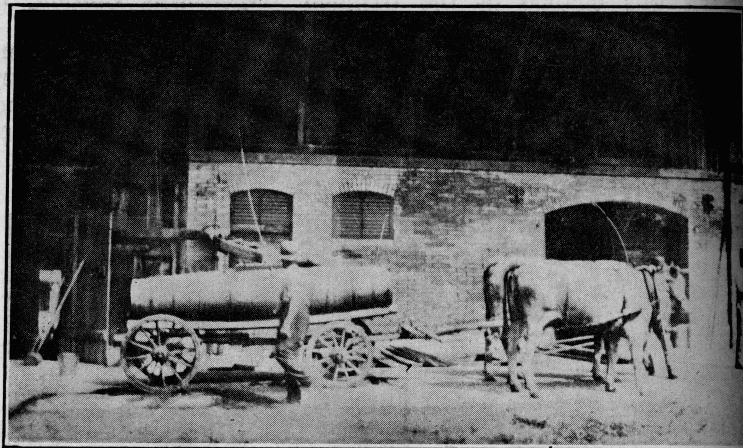

Fig. 4—Tank cart for liquid manure, at Ruetti, Switzerland. The pump for elevating the manure is at the rear, with the trough in place for carrying the liquid to the cart.

APPLICATION OF MANURE.

Manure, is, as a rule, applied once only during a rotation. For example, at Lord Roseberry's farm in Scotland, 20 to 25 tons manure are applied to the potato crop in the rotation. On other Scotch farms, the manure is applied on grass land seeded to oats. The liquid manure appears to be generally applied to grass. The manure is some times applied with a spreader, sometimes from wagons in a pile and spread by hand. In Germany we saw relatively great areas on which piles of manure had been placed ready for distribution. We did not find any farms which did not use manure. On the vineyards in Southern France, where grapes have been grown on the same land and on the same stalk for a period of time beyond the memory of man, they secure and apply manure in liberal amounts.

EFFECTS OF MANURE.

Manure is valuable not only for the plant food which it carries, but also for its chemical and physical effect upon the soil. We had a very striking illustration of the ability of manure to enable land to hold moisture during the drought at the Rothamsted, England, Experiment Station. The season of 1911 was very dry both in England and all over Europe. On a certain field, mangels have been grown with manure and with various fertilizers for 35 years. During the present dry season, there was practically no stand on any of the plots except the one which had the manure. The other plots had been replanted two or three times, but the seed failed to germinate or do well on account of the dry season, and the crop was practically a failure. On the manured land, which had received 14 tons manure per acre the mangels were growing well. On this field the soil texture is in very poor condition where no manure was applied.

At Woburn, England, during dry seasons, both wheat and barley o best of all on the plot receiving farmyard manure.

The lasting effects of manure was seen at the Rothamsted Experiıent Station, and at Woburn. At Rothamsted, one plot had reeived manure for 20 years, and none after that. Barley has been rown on this plot for 58 years and still shows the effect of the ıanure applied 38 years ago. For example, 30 years after the pplication, the barley was twice as large as on the plot which had eceived no applications since 1852. At Woburn, a plot fertilized or a few years with manure continued to give better yields for 25 ears than one which received no manure.

Fig. 5—Farmyard manured plots are in the foreground. Bare plots in the rear fertilized but no manure, and have practically no stand on account of the dry season. Rothamsted, England.

MAINTENANCE OF FERTILITY BY MANURE.

If a farmer saves all the fertility in his manure, the loss of plant ood is only in the crop sold from the farm. There are unavoidable osses in manure, however, so that such is practically impossible. The loss in plant food may be restored by the purchase of feeding stuffs, if the fertility thereby bought in is carefully saved. Such s generally the case, and cottonseed meal from America, palm meal from Africa, and other imported feeds, are thus contributing to the maintenance of the fertility of European soils.

Leguminous crops, which are known to take nitrogen from the air, are extensively grown, used as feed, and so restore nitrogen to the soil. Clover and alfalfa are quite commonly used.

PURCHASE OF IMPORTED FEED STUFFS.

Feeding-stuffs are valuable both as feed for animals, and for their content of plant food. By the purchase of imported feeding-stuffs, the European farmer thus not only secures feed for his animal, but, since both solid and liquid manure are carefully saved, he adds to the plant food in his soil. In my opinion, this is quite an important factor in the maintenance of the fertility of European soils. The rotation of crops usually used, with one leguminous crop at an interval of five to seven years, did not seem, in my opinion, alone sufficient to maintain these soils at the high productiveness which they have. The deficiency is made up by the use of fertilizers and of imported feeding-stuffs.

The soils of the countries which export the feeding stuffs are, of course, losing the plant food which is going to help maintain the fertility of European soils. The Southern States are annually exporting large quantities of plant food in the form of cottonseed cake and meal. Meanwhile, immense amounts of plant food are purchased in the form of commercial fertilizers, and yet many Southern soils are decreasing in fertility. The cottonseed meal exported sells for about enough to pay the farmer for the plant food contained in it. He thus practically gives away its feeding value. The European pays ocean freight, profits to handler and dealer, and then feeds it and gets the feeding value, saves the manure and gets the fertilizing value, makes a profit on the transaction, and increases or maintains the fertility of his soil.

In England, it is estimated that of the fertilizer elements in the feed, one-half of the nitrogen is saved in the manure, three-quarters of the phosphoric acid and all the potash. Thus, the manurial value of cottonseed meal is figured at 56 shillings 5 pence per ton, or approximately $14.00; corn meal, $3.25 per ton; rice meal, $4.50 per ton; clover hay, $5.30 per ton; wheat straw, $1.75. This is the estimated value of the plant food which is recovered in the manure under English conditions. The manurial action is considered to last four years. If the tenant moves the year of the application, the compensation value is as given above. The next year, the compensation value is one-half; the year after, one-fourth, and the fourth year, it is one-eight. That is, the entire value of the manure to the land from a ton of cottonseed meal is $14.00 when first applied. After one year's usage, the residue has a value of $7.00. After two years usage, the residue has a value of $3.50. After three years usage, the residue has a value of $1.75 per ton. Thus, it is assumed that one-half of the value of the remaining manure is consumed each of the four years, excepting the last, after which its effects become so merged with soil fertility that they are no longer noticeable.

USE OF COMMERCIAL FERTILIZERS.

The extensive use of commercial fertilizers undoubtedly plays an important part in maintaining the fertility of European soils. Nitrogen is largely secured by means of leguminous crops, or in purchased feeding stuffs. Some nitrogenous fertilizers are used, however, particularly nitrate of soda and sulphate of ammonia. In Switzerland we were told that the fertility of the soil is maintained without the purchase of any nitrogenous fertilizers whatever.

Commercial fertilizers are quite extensively used in Europe. Acid phosphate or Thomas slag are used most often, potash salts to a less extent. Nitrogenous fertilizers seem to be used to the smallest extent. On account of the careful saving of manure and the leguminous crops grown in the rotation, considerable amounts of nitrogen are secured from the air or applied in the manure. Hence the less general application of nitrogenous fertilizers.

Mixtures.—Ready mixed fertilizers are used to some extent in Scotland and also in other European countries, but the use of the unmixed fertilizer materials is much more common than with us. For example, instead of applying a ready-mixed fertilizer as with us, the European farmer is more likely to apply acid phosphate, potash salts or nitrate of soda or dried blood. As a general rule, a heavy application is made to a valuable crop or one which may be expected to respond well to the application, while the succeeding crop in the rotation may receive little or no fertilizer, but is expected to feed on the residues from the preceding crop. Such a systematic method of applying a fertilizer appears much more desirable and likely to be profitable than the lack of system too often practiced in this country.

It is possible that the more general use of unmixed fertilizers abroad and of mixtures in this country is due to economic conditions. On account of the difference in the cost of labor, it may be better for the European to mix by hand or to make several applications, while the better for the American to mix by machinery in the factory and make but one application.

Rock Phosphate.—Rock phosphate is not considered as a desirable fertilizer. Its use is not recommended by the Association of German Experimental Stations.

Thomas Slag.—In Scotland it is used some on turnips and considerably on grass land. Turnips do not suffer so much from "finger and toe" diseases as when manured with acid phosphate. The yield of turnips is less with the Thomas phosphate than with acid phosphate, but the quality is better. In England, Thomas phosphate gives good results, but it is slow in acting. Thomas phosphate is used some in the valleys at Grignon, France. In Switzerland it is used because it is cheaper.

Potash.—This is not much used in Scotland or England (at Cirencester) and is said not to do much good at Grignon in France. In fact, for general grass and grain farming it does not appear greatly needed, but is used more frequently on potatoes, beets and similar crops.

Fertilizer on Pasture Land.—Fertilizers are used on pasture land, with profitable results. Near Dalmeny Park, in Scotland, we saw a clayey field which had been properly seeded five or six years before, but was very unproductive and poor pasture, being covered with a sparse growth of worthless grasses. About two years ago, 600 pounds per acre of Thomas phosphate had been applied to the land, and the result was dense growth of good pasture grasses. This action was considered due both to the phosphoric acid and to the basic lime carried by the fertilizer in question.

Fertilizers and Maturity.—At Rothamsted, where fertilization tests have been carried on continuously for 60 years, we were told that wheat which received other plant food but no phosphoric acid was always late in maturing grain. A lack of potash cuts short the growth of the plant and makes it mature earlier. Fertilization with potash prolongs the growth of the plant, especially in a dry season. Where the plant is fertilized with nitrogen and potash but no phosphoric acid, the grain will hardly ripen at all.

THE USE OF LIME.

Lime is quite frequently used in Europe. It appears to be used more or less in every locality, except where the soil is naturally calcareous. We found it much used in Switzerland, for example; to some extent in Scotland; also in England, France and other countries. It is an old saying, "Lime makes the father rich and the son poor." This is on account of the property of lime to make some plant food available, thereby increasing the loss from the soil and leaving less for future use. In connection with crop rotation and the use of manure and fertilizers, lime aids in maintaining the soil at a high degree of productiveness.

One use of lime is to correct acidity and bring the soil to a basic reaction, which is more favorable to most crops than an acid condition. But this is not the only action of lime. It flocculates clay soils and makes them more easily worked. It liberates potash so that plants can take it up more readily. It increases the action of bacteria so that they produce more available nitrogen. This action, at times, leads to loss of nitrogen by leaching. All these effects of lime may, indeed, lead to loss of plant food.

LIME AND ACIDITY.

When the soil is fertilized with sulphate of ammonia, it takes out lime and in time the soil becomes acid. With nitrate of soda, this is not the case. In one case, when the nitrogen is removed, the residue is acid; in the other case, it is alkaline. Hence the difference in the effects. The effect of soil acidity is strikingly shown at the Woburn, England, Experiment Station. On the unlimed sulphate of ammonia plots, barley did not grow at all—the plot was bare—and wheat was growing little. Where the acidity was partly neutralized with lime, or, on other plots, neutralized by large applications of lime, the differences were easily perceptible.

At the Rothamsted Station, where sulphate of ammonia was used on the permanent grass land, the soil was beginning to become acid, and peat was beginning to form, but application of lime (on other plots) caused the peat to disappear and a change in the character of the vegetation. Similar results could be seen on the grass land at Woburn.

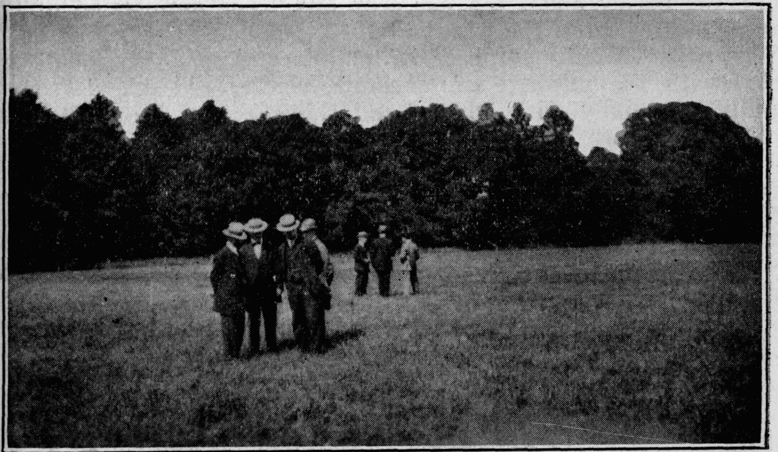

Fig. 6—Permanent hay field at Rothamsted, England. Where sulphate of ammonia is used, the soil is becoming acid, shown by the peaty formations in it.

Formation of Acid Soils.—The effect of fertilizers and manures on the production of acid soils is strikingly shown on the wheat and the barley fields of the Woburn, England, Experiment Station. These fields have been cultivated continuously to wheat and barley for 34 years, with different manurial applications. No acidity has developed where farmyard manure alone has been used continuously, or rape dust alone or a mixture of acid phosphate, nitrate of soda and sulphate of potash. Wherever sulphate of ammonia has been used, alone or in combination, acidity has developed after a time. The results on some of the plots are shown in the following table:

	Average produce in bushels per acre. Wheat.		
	1877-1896	1897-1906	1910
No manure	14.7	8.6	13.5
Sulphate of ammonia	23.8	9.7	none
Sulphate of ammonia, two tons lime, Dec., 1897	23.8	16.8	23.4
Nitrate of soda	23.6	17.0	23.3
Acid phosphate, sulphate of potash, sulphate of ammonia	30.2	24.4	17.0
Sulphate of ammonia, two tons lime, Dec. 1897, on barley; one ton on wheat, 1905	....	....	24.1
Acid phosphate, sulphate of potash, nitrate of soda	31.2	23.6	23.3

This sulphate of ammonia did not apparently affect the soil during the first *twenty* years, in either wheat or barley. In the next ten years, the soil began to be acid. The barley is much more sensitive to acidity than the wheat, and falls off more in yield in consequence. Lime was added in December, 1897, to part of the sulphate of ammonia plants, and increased the average yield for wheat to nearly the same as for nitrate of soda for the next ten years, for barley about ten per cent less. The application of lime was still effective on the wheat in 1910, but had disappeared on the barley plot. Where sulphate of potash and acid phosphate was added with the sulphate of ammonia, acidity did not develop so rapidly, especially with wheat; and the effect of the applications of lime was more lasting.

Fig. 7—Barley field at Woburn, England. The bare plot has received sulphate of ammonia, and is now so acid that it will not grow barley.

On account of the presence of more lime in the soil, experiments at the Rothamsted Experiment Station have not shown a development of the acidity due to sulphate of ammonia, except in the grass land mown for hay every year. These experiments were begun in 1856 and the land has been in grass several centuries. Where sulphate of ammonia is used, the soil has become somewhat acid, and vegetation tends to decay into a peat-like substance.

We judge from the experiments above recorded, that the use of acid phosphate or potash salts in connection with farmyard manure, cottonseed meal or tankage, and especially nitrate of soda, is not likely to lead to soil acidity, but where sulphate of ammonia is used, the soil is likely to become acid in time.

PREVENTION OF LOSS OF PLANT FOOD.

European farmers are careful to prevent all loss of plant food possible. Everything of fertilizing value is saved. Liquid manure is saved and used. Some landlords do not allow hay or straw to be sold from the farm unless equivalent amount of food or fertilizer are purchased. That is to say, they restrict the outgo of plant food which is sold in the farm products.

EXPERIMENTS AT ROTHAMSTED AND WOBURN, ENGLAND.

The fertilizer experiments on wheat and barley at Rothamsted were begun in 1843 and since 1852 they have been going continuously upon the same land without fertilizer and with various manurial applications. The experiments on the Woburn field were begun in 1877 and the crops of this year are the 35th season.

The work at Rothamsted and at Woburn have given important results for agriculture, which has been presented in a number of publications. We can only refer to a few of these conclusions.

The yields of wheat without fertilizer at Rothamsted had decreased from 15.9 bushels per acre, average for the ten years—1852 to 1861—to 12.3 bushels, average 1892 to 1901. Director Hall believes that the plots can maintain an average yield of about 12 bushels for a good many years. That is to say, the amount of plant food furnished by this soil will supply sufficient for a crop of this size.

Fig. 8—Permanent wheat field at Rothamsted. The plot at the left has received no fertilizer for 59 years, the one at the right has received stable manure.

The yield on the unmanured plot at Woburn was 14.7 bushels average for the first 20 years and 8.6 bushels for the next 10 years. This soil, therefore, does not maintain as high an average yield of wheat as that at Rothamsted, although it has been cropped for about 25 years less. The average yield of wheat in the United States is 12 bushels.

The highest average yields at Rothamsted for the 10 years—1893 to 1902—is on the plot receiving 14 tons of barnyard manure per year and yields at the rate of 40 bushels per year. Next comes the field which received 600 pounds per acre of sulphate of ammonia, 200 pounds sulphate of potash and 350 pounds superphosphate containing 37 per cent available phosphoric acid. This yield was 39.2 bushels per year. The next highest yields are from the plots which receive 400 pounds ammonium salts; or 550 pounds of nitrate of soda per year in connection with the superphosphate and potash salts mentioned above. This yield was at the rate of 32.5 bushels per acre.

The highest average yield at Woburn for the ten years—1897 to 1906—was 29.1 bushels per acre on the plot which received 300 pounds superphosphate; 50 pounds sulphate of potash and 500 pounds nitrate of soda per year. The next highest average yield was on that which received rape dust. (Ground residue from rape seeds which have been pressed to extract oil.) The barnyard manure plot yielded 24 bushels per acre. It is concluded from the experiments at Rothamsted that wheat needs mainly a nitrogenous fertilizer. When it is grown two or three years in succession on the same soil it is also likely to need phosphoric acid. It does not need potash on this soil and Director Hall believes that potash salts will not pay on wheat, excepting on the lightest sandy soils.

The highest yield of barley for the ten years—1892 to 1901—is also on the plot which received barnyard manure, 44.3 bushels per acre. On the unmanured plot, the yield decreased from 22.4 bushels in the decade 1852 to 1861 to 10 bushels in 1892 to 1901. The highest yield at Woburn was on the plot receiving superphosphate, potash salts and nitrate of soda, being 42.8 bushels per acre. The yield on the barnyard manure plot was 36.6 bushels and with no fertilizer the yield decreased from 22.4 bushels to 21.09 bushels in the period 1877 to 1896, and to 11.5 bushels in the ten years 1897 to 1907. Director Hall concludes that barley, like wheat, needs nitrogenous fertilizer worst of all, but also needs a good supply of phosphoric acid. Potash does not seem to be needed.

Fig. 9—Tubercular calf experiment at Woburn. These calves were born of tuberculous cows, but were immediately separated from them and fed on sterilized food, to see if they inherited any tuberculosis.

THE TENANT AND FERTILITY.

Good farming lands in Europe are worth $500 per acre up and pay about 2 to 3 per cent net on the value of the land to the owner. Of course there are cases in which the returns are greater. The tenant has to keep up the farm, pay taxes, etc., so that the cost is more than the above to him. But the tenant's income from the land is greater than the owner's. This low income on the value of the land has a tendency to concentrate land ownership in the hands of the wealthier classes. The farmer prefers to invest his money in live stock and implements rather than in land. Further, a man with small capital can not afford to invest on such a low return. A tenant farmer can establish his sons on rented farms, but if he invests his money in land, when subdivided, the farms become too small for his descendents to earn a good living on. There appears to be thus a tendency for farming lands to enter into, and remain, the possession of wealthy owners. In France, indeed, there are a great many farmers who own their own farms.

The European tenant is not allowed to rob the soil of its fertility, and then move on in search of other lands to rob. Custom and laws require that he follow the systems of good farming, and these tend to preserve the land fertility. A tenant is responsible not only for the condition of the buildings which he has occupied, but also for the soil he has worked. When he vacates the farm, it is examined and assessed. He receives compensation for any values he may leave, and on the other hand, he is liable for any depreciation. The soil must be in as good condition when he goes as when he comes. The customs are of course different in different countries, but they are in general in this direction.

Leases in some instances are 15 to 20 years, in other places from year to year, but practically no farmer gives up a farm unless forced to do so, on account of the expense involved in moving.

FORM OF LEASE.

The following extracts from a farm lease used on a large estate in Scotland illustrates and emphasizes what was said above. It is also of interest in showing methods of farming, etc., referred to above.

FIRE INSURANCE ON BUILDINGS AND STOCK.

"The tenants shall repay yearly to the proprietor, along with the Candlemas rent, the annual premium on an insurance against fire, to be effected in name of the proprietor, over the whole houses and buildings on their farms, and the tenants shall also insure and keep insured in their own names their whole stock and crop, and shall, if desired, exhibit to the proprietor or the factor, receipts for the premiums payable thereon when paying rent, any sums to be recovered under the insurance on houses and buildings to be applied by the proprietor in rebuilding or restoring the same. The tenants shall have no claim against the proprietor for any loss alleged to have been sustained by them by or in consequence of such fire.

BUILDINGS, FENCES, ROADS, DRAINS, WATER SUPPLY, ETC.

"The tenants at their entry shall, in the absence of any agreement to the contrary, be subject to such expenditure by the proprietor as may be stipulated in the Minute of Lease, accept of all the houses, buildings, fences, gates, roads, drains, watercourses, ditches, and water supply, on their respective farms and possessions, as in good and tenantable condition and repair and sufficient for the farm, and shall be bound to uphold them in like condition during the currency of the lease, and leave them so at the expiry of their lease (natural decay always excepted). The outside iron and woodwork of the houses and buildings, and also all the gates, shall receive at the proved by the proprietor or his factor) every four years, and all proved by the proprietor of his factor) every four years, and all the ironwork of the fences shall receive at the tenant's expense a coat of black varnish every four years. All march fences shall be kept up at the mutual expense of the coterminous tenants. The proprietor reserves power to make a periodical inspection of the respective farms and possessions, and also the power, failing the performance by the tenants at any time during the lease of any of these obligations as to maintenance, to have the work carried out by workmen employed by himself and to charge the tenents with the expense thereof.

CROPPING AND MANAGEMENT OF LAND.

"With regard to the cultivation and management of the lands, the tenants shall be bound to manage them according to the most approved rules of good husbandry, and without prejudice to the said generality, the arable lands shall be cultivated according to the system or shift or rotation prescribed in the Missives of Lease or Minute of Lease. If a four-course shift or rotation be prescribed, the lands shall be kept in four parts of divisions, as nearly equal in extent as possible, of which divisions one shall be in a green crop of turnips, or potatoes, or other green crop; one in corn crop ('corn' means grain), following a green crop, and sown out with suitable grass and clover seeds; one in grass for hay, or for cutting green, or for pasture; and one for corn crop after one-year-old grass. If a five-course shift or rotation be prescribed, the lands shall be kept in five parts or divisions, as nearly equal in extent as possible, of which four shall be under the same crop as for a four-course of rotation, but the corn crop after grass shall be after two-year-old grass, and the fifth division shall be in two-year-old grass for first or second year's pasture. If a six-course shift or rotation be prescribed, the lands shall be kept in six parts or divisions, as nearly equal in extent as possible, of which five shall be under the same crop as for a five-course shift or rotation, but the crop after grass shall be after three-year-old grass, and the sixth division shall be in three-year-old grass for second or third year's pasture.

"The tenants shall apply to the lands all along the dung made upon the farm, and in addition to the dung, not less than two pounds sterling worth of suitable genuine artificial manure for every imperial acre under green crop, or an equivalent in additional dung made upon the farm by the consumption of purchased feeding stuffs, and it is hereby conditioned and declared that the extent of land under potatoes or green crop, other than turnips, in any one year, shall not exceed one-half of the land under green crop. And, except as regards the produce of the last crop under the lease, the tenants shall be bound not to sell or carry away off the farm any hay, grass, straw, turnips, or green crop other than potatoes (except on the conditions aftermentioned), but the whole shall be regularly consumed and made into dung, and the whole dung made therefrom shall be regularly applied to the lands. Declaring, however, that notwithstanding the above prohibition regarding the sale of hay, grass, straw or turnips, that the tenants shall be entitled to sell the same on the following conditions, videlicet: That for each ton of hay sold, or its equivalent in grass, they shall purchase and apply to the crop of the succeeding year six tons of the best horse or cow dung, or not less than 40 shillings worth of suitable genuine artificial manure, or in lieu thereof purchase and consume upon the lands for the benefit of the crop of the succeeding year feeding stuffs equivalent in manurial value to said manure; for each ton of straw sold, three tons of best horse or cow dung; and for each ton of turnips (or green crop other than potatoes sold), one ton of best horse or cow dung.

GRASS SEEDS SOWN WITH WAY-GOING CROP.

"The ingoing tenant at entry to the lands shall pay the cost of the grass and clover seeds sown by the outgoing tenant with the last crop, and at termination of lease shall, in like manner, be repaid the cost of the grass and clover seeds to be sown with the last crop (if the seeds are not supplied by the proprietor, which he shall be entitled to do), and the tenant shall not allow any live stock whatever to pasture upon such sown grass.

TAKING OVER OF WAY-GOING CROP.

"The proprietor or incoming tenant shall, at the expiry of the lease, whether at the natural or at any prior, have the option of taking over at the Martinmas term of removal, the whole of the corn and turnip crops of the last year at a valuation to be fixed by arbitration, but the decision to take over these crops must be intimated to the tenants not later than the first day of July in that year. In the case of a Whitsunday entry, the ingoing tenant shall pay the outgoing tenant for the labor, seeding and manuring of the grain and turnip crop of that year such sum as may be fixed by arbitration, and at termination of lease shall, in like manner, be repaid for the labor, seeding and manuring, up to term of removal, for the crop of that year, which he shall be bound to perform as if the lease had continued.

HEATHER BURNING.

"The regulation as to heather burning on farms described as pastoral in the Missives of Lease or Minute of Lease will be prescribed in the Missives of Lease or Minute of Lease. In all other cases the tenants shall be bound to not burn heather on any part of the lands left to them (where there is heather on the farm without the special written consent of the proprietor or his factor."

WHEAT SEED SELECTION.

Philip Vilmorin is the largest seed grower in France. His family has been in the business over a century. Besides a good many other seeds, he grows 1200 varieties of wheat, 600 each year in alternate years. His method of selecting wheat is of general interest. Each year three of the best heads, true to type, are selected, and planted in three small plots. The best of the three plots is selected and the seed used to plant a larger plot, and the third year for a still larger plot, and the fourth year the seed is sent out to the collaborators for the production of commercial seed wheat. Each lot of seed thus came from a single head of peat. The three best heads are selected from the plot, and so it has gone on for a long time. Quite recently a number of selected heads were found which were fifty to sixty years old, and the same varieties of wheat today, after fifty or sixty years of selection, were practically the same as then. That is to say, the selection had caused no improvement. Vilmorin's theory to account for this is that the wheat was pure and could not be improved further by selection.

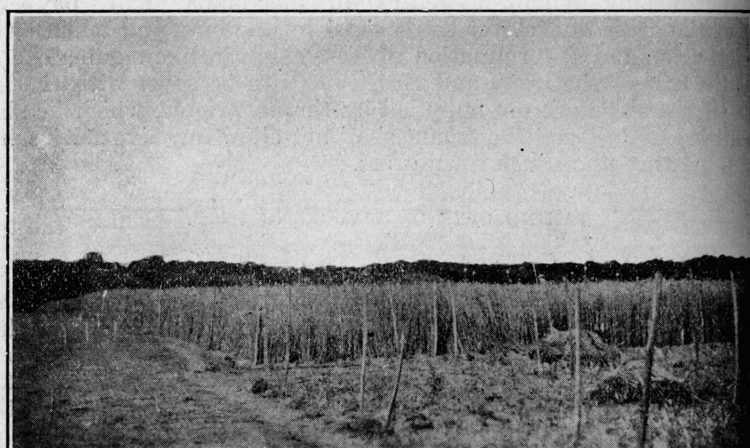

Fig. 10—Seed wheat plots of Vilmorin. Each plot is grown from the grain of a single head.

COMPETITION IN ECONOMIC MILK PRODUCTION.

In Denmark we were told about milk competitions. The object of these competitions is to encourage the economical production of milk and butter fat. The competition is carried on between the different dairy farms of each locality. A record must be kept of the quantity and kind of feed, the amount of milk, and its content of butter fat. An inspector comes twice a month, verifies the records, weighs the feed and milk and tests the milk for fat. The prize goes to the herd making the most economical production.

FARM BUILDINGS.

The European farm buildings are compactly built, quite often with a court yard surrounded by the farm buildings. The house is at one side of the court, with sheds, barns, storage houses, etc., adjoining it and surrounding the court yard. The court yard is paved and contains the manure pile. The buildings are of stone or brick, with tile roofs. Some now are of concrete. This compact arrangement allows the farmer to oversee the work of the farmstead without loss of time in going from one place to another. The farmer's wife can also keep an eye upon the court when the farmer is away.

In Holland and Belgium the arrangement is different. Here the house and barn are under the same roof, though practically separate. Usually the house part is painted a little different color and can otherwise be distinguished. The court may or may not be present. Often there is none. The arrangement allows the farmer to attend to his animals without going outside in bad weather. It also enables the farmer's wife to oversee the operations of the farm to some extent when necessary.

Fig. 11—House and barn in Holland, under the same roof, but practically separate. The dark-colored roof to the right is the barn part. (See also Fig. 12.)

At Belair, in Belgium, we saw a model farmstead designed by Dr. Du Vuyst, Commissioner of Agriculture for Belgium. As this model is of interest, we will give the plan of it, which explains itself.

CITY MILK SUPPLY.

Two decidedly different systems of dealing with the milk supply of large cities were seen at Dresden and at Copenhagen.

At Dresden the milk is collected at various centers and shipped in

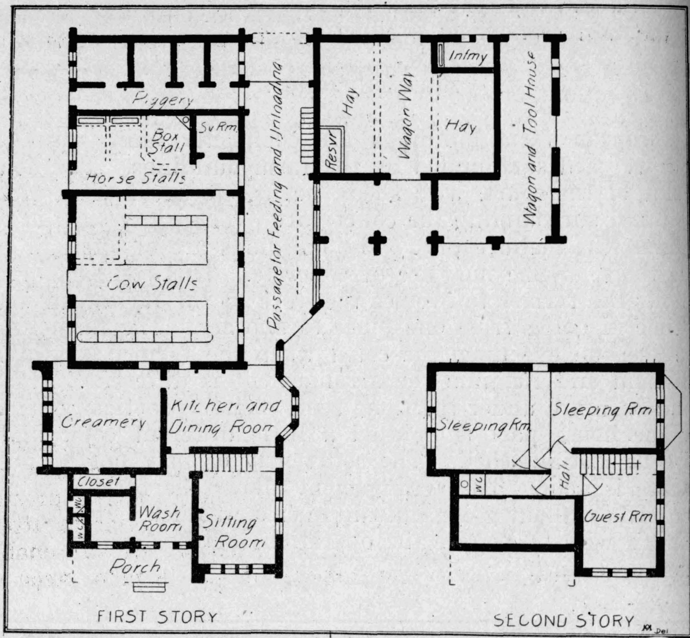

Fig. 12—Plan of model farmstead at Belair, Belgium.

by rail. It is tested for butter fat and sweetness and inferior milk rejected. It is then run through a centrifuge for taking out coarse impurities. It then runs into a large vat (capacity 6000 quarts) heated by steam, with a thermometer which rings at 60 and at 62 degrees C. It is maintained at this temperature for one-half hour, cooled and bottled or placed in cans. Each bottle is sealed with a label showing date of bottling. The unsold milk is collected every day and used for making butter. Thorough systems were in use for sealing and washing bottles and other articles which come in contact with the milk| The milk cans are provided with a ventilator, and with an agitator to prevent cream from rising. The milk in bottles sells for 5½ cents per quart, while from the can it is 5 cents per quart.

The object in heating the milk is to destroy the bacteria in it. All bacteria are not destroyed at this temperature, but most of them are, especially disease germs. The milk, however, is collected from the dealers before the remaining bacteria have time to develop. On account of the low temperature of heating, the milk has no taste of being cooked. The milk supply company in question also prepares milk which has been sterilized by heating at high temperatures (1½ hours at 105 degrees). This is especially used for children. It also prepares milk pasteurized at different temperatures to suit the opinion of different physicians.

This appears to me to be an excellent plan of dealing with the milk supply of a large city. The consumers of the milk are protected against any disease germ which may accidentally have gotten in the milk. In hauling such large quantities of milk, any contamination of any source of supply contaminates the entire quantity with which it is mixed. The treatment of pasteurization, however, prevents such contamination. Further, if any of the cows are affected by tuberculosis, which is quite likely to be the case, then the treatment destroys these germs and prevents them from permeating the entire milk supply.

The city of Dresden recognizes two grades of milk. The first grade contains 2.8 per cent butter fat. The second grade contains less than 2.8 per cent butter fat, but must have no added water.

The milk supply at Copenhagen is on a different system. The farmers who supply the milk must cool it at once, and ship it packed in ice. When the milk arrives it is tasted and tested with a thermometer. If there is any foreign taste, or if the milk is warmer than allowed, it is rejected. The milk is cleaned, bottled, sealed with date of bottling, and delivered packed in ice. For infants' milk, much greater care is exercised. The milk is taken from cows which have passed the tuberculin test, and therefore free from tuberculosis. The cow is milked in a room in which only one cow and two persons are allowed at time of milking. The milk is milked directly upon a metal vessel filled with a mixture of ice and salt, so that the milk is cooled at once to a low temperature. Like the other milk, the infants' milk is shipped in cans surrounded with ice.

The two systems of milk supply outlined before are quite different. The Dresden system consists in destroying the bacteria after the milk reaches the city. The Copenhagen system consists in preventing the growth of the bacteria by lowering its temperature and by precautions in milking. The latter system is, of course, more expensive, and also more liable of failure. Any carelessness on the part of any contributor may contaminate the milk. On the other hand,

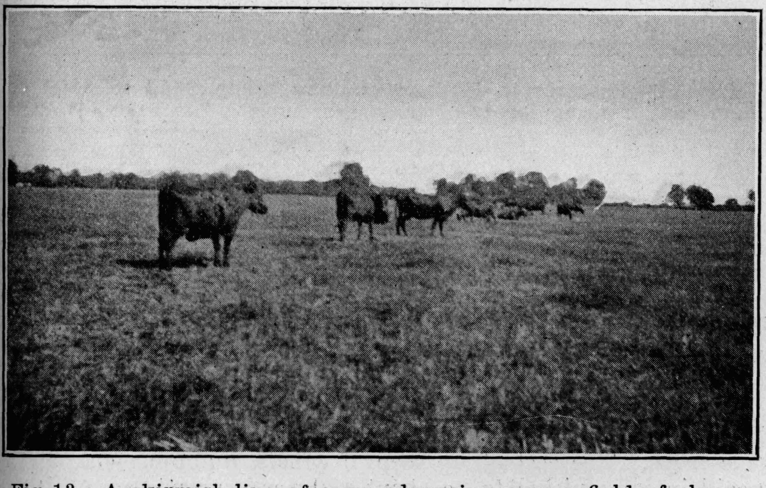

Fig 13—A skirmish-line of cows advancing over a field of clover. The cows are staked out and are milked and watered in the field. Denmark.

the low temperature at which the milk is kept undoubtedly would tend to minimize such contamination.

A considerable quantity of buttermilk is sold in Europe. Pfund Brothers, in Dresden, for example, sell 30,000 quarts sweet milk and 4,000 quarts buttermilk per day. A quantity is churned for the purpose of making buttermilk, the butter being a by-product. We found this to be the case at a number of creameries which we visited. They also prepare a buttermilk or sour milk by inoculating sweet milk with a special ferment. In Dresden, Germany, this product was solid, and was called "yoghurt." At Kingston, England, we sampled soured milk prepared in this way, which was similar to buttermilk, but had a very fine flavor. This soured milk was called Yorger milk at Gimritz, Germany, and there said to be good for stomachic affections caused by bacteria, and also for the headache caused by alcoholic excesses.

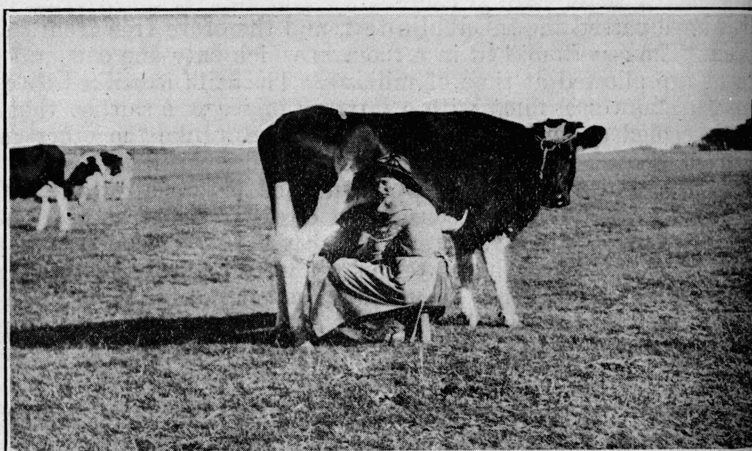

Fig. 14—Pastures in Holland on land worth $600 to $800 per acre and renting for $30 per acre or more. Drainage—Holland.

DRAINAGE—HOLLAND.

A portion of Holland is below the level of the sea, 20 feet. Water is drained from the land by means of drainage ditches into canals. The ditches are V-shaped and serve for fences. The water is pumped from the lowest levels in two lifts of about ten feet each. The great canals are, some of them, slightly below sea level, and the water is pumped from them into the sea at low tide. We saw such a pumping system on the great canal near Amsterdam.

The low-lands are both drained and irrigated by the canals. They thus contain an abundance of water, though they are too wet for some crops. The cost of up-keep of canals, pumping, etc., and rent, is said in some places to be about $30 per year per acre. It is evident that the land must be intensively farmed to produce a return on such money. This land seems to be very largely devoted to dairy farms, to judge from our observations.

The land is worth from $200 to $1,000 an acre, and rents from $20 to $100 per acre. The high-priced land is used mostly for nursery stock and bulbs. The other land is used almost entirely for dairying. At one dairy farm we visited, 35 cows and two bulls are kept on 75 acres of land rented at $30 per acre. Fifty acres are pastured from May 1 to December 1, and 25 acres are cut for hay. The grass grows rich and rank on account of the high fertility of the soil and the under-irrigation from the canals. In the winter the cows receive hay, oats, corn from America, beet pulp and linseed meal. In the summer they are pastured. The milk is made into two cheeses of about 140 pounds per day, and the whey is fed to the calves and pigs. The manure from all the animals goes back onto the farm. This family has a net income of about $2,000 a year from this farm.

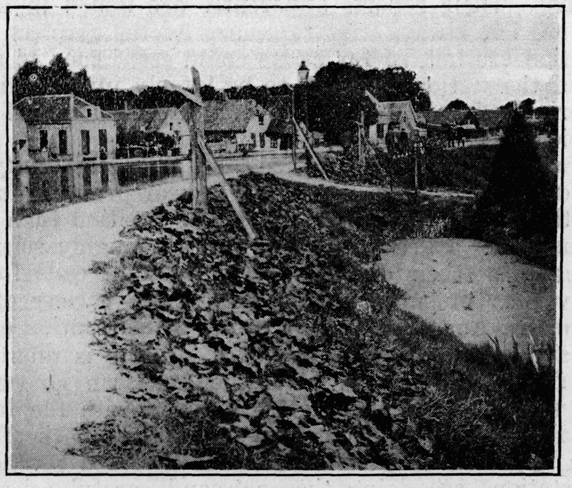

Fig. 15—Two canal levels in Holland. The canal at the left is the main canal from Amsterdam. The canal at the right is eight feet below the main canal. Water is raised by wind mills or steam pumps.

AGRICULTURAL MUSEUMS.

In Switzerland, Germany, Denmark and Holland we visited a number of agricultural museums. The collections consist not only of minerals, insects, agricultural products and agricultural by-products, woods, etc., but also contain models of various types of farm animals, models and specimens of agricultural implements and machinery, charts and models showing various agricultural operations and the best way to perform them, models of buildings, illustrations showing advancement of scientific investigation, insects, pests, and the manner in which they attack, etc. These collections were as a rule in connection with some agricultural school or college, and were used for purposes of illustration and demonstration. Undoubtedly they have a high educational value.

Probably the largest and best of these collections which we visited was located at Berlin, in Germany. The museum had a large central hall, in which were placed the larger specimens, and working models of a number of machines, such as hay unloaders, etc. A number of the machines or models were undoubtedly placed there by the manufacturers or promoters of them.

EXPERIMENT STATIONS.

The foreign experiment stations are quite different from those in America. They select certain well-defined lines of work and continue the work for years. Their work is marked by continuity of purpose and of experiment. They are thus more likely to secure permanent results.

These experiment stations do not possess the machinery for distributing their experiments among the people as used by the American stations. Their reports apparently are issued in limited editions, and are not always easy to secure by the farmers. Bulletins of information are not, so far as we could see, issued to any extent. The work of the stations appears to be largely investigation, control of fertilizers, feeds and seeds, but not distribution and dissemination of agricultural information.

The European experiment stations, by their continuity of work, concentration along narrow lines, and lack of pressure for information from the farmer, are thus in a better position than the American stations to do a greater quantity of thoroughly scientific work with the means at their disposal. The constant calls for information on a variety of subjects, and the greater variety of work demanded from an American station, causes a distribution of resources and much study of temporary problems. There is thus less opportunity for fundamental work. But the American Experiment Station appears to be more thoroughly in touch with the farmer, and the practical problems which he has to meet, than the foreign station, which appeared to have a somewhat detached position. While European stations are doing thorough and careful scientific work, we believe our stations are doing better work for the advancement of practical agriculture.

A GIRLS' SCHOOL FARM.

We were much struck with the school for farm girls at Meisjes, Belgium. This school aims to educate girls back to the farm, rather than away from it. It, therefore, accustoms the pupils to such things as they have, or can get, on the farm. The farmer's wife, as a rule, can not get desks. The school room in this school is, therefore, equipped with tables and not school desks. The pictures and other things in the school room or school farm house are not expensive or beyond the means of the farm. Thus when the girl goes back, she is not dissatisfied with what she has at home, because the things at school were so much finer.

The girls, under supervision, do all the work of farm, garden, dairy and kitchen, such as they would do at home. There is a man to attend to the heavy work, but the girls do the rest. The 18 girls who average 15 years old, are divided into four sections, one section for the kitchen and dining room work, one for washing and household work, one for the cows, poultry, bees, etc., one for the lairy butter and cheese making, milking, testing, etc. The girls do all the work of the school, and the only expense is the cost of the board. This is about 80 centimes a day, or 15 cents. The different sections change every fortnight, and there is keen competition between the different groups, especially in the culinary department, in which the object is to provide the best board for the least money. They have books in which are recorded menus for 20 years—ever since the school began. The girls remain as a rule for one year. We saw on the walls pictures illustrating good and poor ways to do things. There was, for example, a picture showing one woman doing as much work with a washing machine as three women by hand. Another picture showed good and poor ways of arranging flowers for the house. The object of these is, of course, teaching. The idea for these pictures came from America—Cornell.

This school appeared to us to be an excellent one for educating the girls to be happy on the farm and to do or know how to do what is to be done, well and intelligently.

Such a school is, of course, a trade school, and betted adapted to stable social conditions than to American conditions, where each girl may have an opportunity for high advancement. Nevertheless, such a school offers suggestions of value in training for life and for humble duties, rather than for acquiring ambitions which can not be realized.

Fig. 16—Milking in the fields—Holland.

CO-OPERATION.

We observed co-operation between farmers more largely in Denmark. The farmers in this country seem to co-operate in a great many ways.

At Kjolding and at Odense we visited co-operative slaughter houses. The slaughtering of hogs was done, so far as we could see, in about the same way as in the American packing houses, except the workers were slower. The interesting feature is the co-operative part.

Each co-operator undertakes to deliver a certain number of hogs each year, on an average, about 20 or 30. If he does not perform his part of the contract, he is liable for damages, and they are easily assessed and collected. The hogs are paid for the day after they are received. The meat is shipped to an agent in London, who sells it on commission. At regular intervals the profits are divided between the co-operators, according to the number of animals furnished. The management also receives some share of the profits. This method of co-operation places the farmer in direct touch with the retail butcher and gives him the advantage of market prices.

This is the general scheme. The details are different in different localities. The main feature of the plan is that all parties are obliged to fill their part of the contract. The plan works well. About 64,000 hogs are killed in this place for 3,000 co-operating farmers. The pigs weigh not over 200 pounds, and must not be very fat, since the market requires lean bacon and small hams. The pigs are about six months old, and are fed mainly on separator milk, on dried blood from the slaughter houses, on root crops and on clover.

At Nykobing the business is in charge of a committee of men elected by the co-operators.

At Leuwarden, Holland, we visited a co-operative butter-control laboratory. The co-operating creameries are furnished numbered paper wrappers or covers for the butter tubs, which are broken when applied, so that they can not be used again. The control laboratory collects samples of butter from each creamery, also samples of cream which are churned, and the butter so made analyzed. When a complaint comes in, the particular creamery and date of shipment can be traced by the number on the package, and the analysis of the suspected butter compared with the official samples. This station is maintained for the protection of the creameries which contribute to it against outside adulteration. It has State recognition. The director said that no case of adulteration on the part of the contributing creameries had ever occurred.

At Nykjobing, Denmark, we also saw a co-operative mill and bakery. The motive power for the mill was a large, old-style Dutch windmill, said to be capable of developing 200-horse power. About 150 co-operating farmers bring their wheat and rye here to be ground and 220 families get their bread from this mill and bakery at very low prices.

A beet sugar factory, partly co-operative, is also located at Nykjobing. Each shareholder binds himself to furnish a certain acreage of sugar beets, at market price, and each afterwards receives a certain share of the profits of the mill. The beet pulp is dried and used for feed.

There are to be 36 co-operative slaughter houses in Denmark, and 25 non-co-operative.

At Odense, Denmark, we visited a co-operative creamery and cheese factory. There are about 130 farmers who hold shares. The factory is up to date, cement floors, tiles, etc. The farmers receive about three cents per quart for their milk, and it retails for about five cents. About 10,000 quarts milk per day are handled. About 300 pounds butter are made. The co-operators, of course, receive a share of the profits.

The main feature about these co-operative establishments appears to be that they bring the *consumer* and *producer* more closely together. The producer gets a better price for his products, and the consumer gets his purchases at a lower price. By maintaining their goods of standard quality, placing the business on an up-to-date basis, and dealing directly with the consumer, the farmer maintains a regular and steady market for his products at a reasonable and profitable price. He also reaps at least part of the benefit of any changes in market prices.

WASTE LANDS.

We saw little waste land in Continental Europe. In England and Scotland there were considerable areas in private parks, in straggling hedges, stone fences and in grazing pasture land. On the continent, however, we saw practically no fences. There were a few dirt fences in Northern Germany, and in Holland the necessary drainage ditches serve as fences, but otherwise fences were conspicuous by their absence. In the case of two adjoining farms, the land was planted to the very dividing line. The line seems to be marked by stones set in the ground. It would appear that this method of marking would cause much dispute, but such is not the case. In case of dispute the matter is settled by arbitration. It allows every foot of the ground to be utilized. The land along roads and hedges is also utilized, and mountain sides too rocky or too steep for planting are used for grazing or for hay crops, the grass being cut by hand.

FORESTRY.

Considering the value of land in Europe, it was a surprise to find so much planted in forests. The forests are splendid, with trees growing close together and straight without branches until near the top. The trees are uniform in size. The smaller trees and underbrush are cut out from time to time and sold for fire wood.

The forest area is, by law, constant in some of the countries visited. When the trees are harvested at the end of 50 years, or longer, as the case may be, a new plantation of equal area must be made and cared for. Although the forests are often on land of low agricultural value, yet we sometimes saw plantings upon what appeared to be good land. Particularly in Germany and in Switzerland did we see many large plantings of young trees.

When the trees are properly cared for, forests are no doubt profitable. It is a long time to wait for the harvest, when a beginning is just being made, but, once started, there is a portion of the forest which can be utilized every year.

It appears to the writer, in passing through the pine forests of the South, that the Southern States should take steps to conserve their forests, to instruct the owners how to take care of them so as to secure profit, to take measures for forest plantings; if necessary to limit by law the cuttings which should be made, and provide for plantings, which shall take their place. It is not too soon to begin to take up forestry and apply it to the conservation of our own.

It is said that 28 per cent of Switzerland is covered with forests and this percentage can not be diminished. When any area is cut an equal amount must be planted in forest trees.

In the forest of Tervueren, near Brussels, in Belgium, Professor Chas. Bommer has arranged a collection of trees of a great many types from all parts of the temperate zone. The objects of this collection are both practical and scientific, first, to secure species of trees adapted to the various purposes of the country, and second, to have a living collection of trees for scientific study. Over 6,000 specimens are in the collection, and they represent America, Asia, Europe and Africa, being in groups according to their geographical distribution. This collection is very interesting.

ECONOMIC CONDITIONS.

European countries differ in two important particulars from American, which influence agricultural practice.

One is the comparatively low wage paid the European laborer. For this reason agricultural operations are conducted more by hand and less by machinery. Both men and women work in the fields. We saw a great deal of hand labor—hay cut and raked by hand, grain cut by hand, etc. For the same reason, agricultural operations which are profitable to them would not be so profitable to us. In general we found a great deal more hand labor and less horse and machine labor than in America.

The second great economic factor is the high value of land. Land is so valuable that it must be worked intensively, and as much as possible secured from it. Furthermore, the land must not run down in fertility. It is too valuable for such to be allowed.

DRY SEASON AND EFFECT ON CROPS.

The season of 1911 during our visit was unusually dry, and the crops suffered greatly. The sugar beet yield, the hay crop, and all other crops had suffered more or less. The milk production of the dairy farms had fallen off, and unusual feeds were being used. We saw at one place *rice hulls* in small quantity being fed to dairy cows at a cost of $17.00 per ton, and though the owner recognized the low feeding value of this material, he said it was an unusual season and he was obliged to use what he could get.

Dry seasons are not unusual in Texas, and we were enabled to make some observations of value. We were particularly struck by the advantage of stable manure to enable a soil to hold moisture and keep in good condition during drouth. We have already referred to this under another head, where we hold how beets made a stand where the manure had been used, and did not where artificial fertilizers had been used with no manure. Manure is used so extensively in Europe that there are few opportunities for other comparison.

SUMMARY AND CONCLUSIONS.

(1) This bulletin is a description of some observations on European agriculture which it is thought may be of value to Texas.

(2) European farms are maintained at a high degree of fertility.

(3) The methods of maintaining fertility involve rotation of crops, careful saving of liquid and solid manure, use of lime, liberal use of commercial fertilizers and prevention of loss of plant food. These are discussed in the Bulletin.

(4) Dairy, stock and grain farming are extensively practiced.

(5) The tenant is not allowed to run down the fertility of land. Leases and customs prescribe methods which shall maintain soil fertility.

(6) Co-operative marketing of farm products is extensively practiced in Denmark. The producer thereby sells his products almost directly to the consumer.

(7) The school for farm girls at Meisjes, Belgium, gives practical training for housework, dairying, and other home work, and prepares the girls to be intelligent and helpful farmers' wives.